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Malaysian palm oil: Surviving the food versus fuel dispute for a sustainable future

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ABSTRACT

For the past few decades, palm oil has gone through a revolution that few would have predicted. From a humble source of edible oil that was heavily criticized as being un-healthy and un-fit for human consumption, it has proven itself based on scientific findings that it is indeed one of the most nutritious edible oils in the world. Besides, palm oil, the cheapest vegetable oil in the market has diversified as one of the main feedstock for oleo-chemical industries. Recently, with the price of crude petroleum hitting records height every other day, palm oil has become one of the few feasible sources for biodiesel, a renewable substitute for petroleum-derived diesel. Nevertheless, the conversion of palm oil into biodiesel has again received criticism from various NGOs worldwide, mainly on extinction of orang utans, deforestation and particularly the food versus fuel dispute. It was claimed that the conversion of food crops to fuel would significantly increase the number of undernourished people in the world. Malaysia, being the world second largest producer of palm oil, is not spared from this criticism. On the contrary, in the present study it was found that palm oil is indeed the most economical and sustainable source of food and biofuel in the world market. Besides, it was shown that it has the capacity to fulfill both demands simultaneously rather than engaging in priority debate. Nevertheless, fuel is now a necessity rather than a luxury for economy and development purposes. A few strategies will then be presented on how palm oil can survive in this feud and emerged as the main supply of affordable and healthy source of edible oil while concurrently satisfying the market demand for biodiesel throughout the world.

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1. Introduction

The world is currently facing the worst energy crisis in its entire history. Many countries in the world are still heavily dependent on crude petroleum as the source of electricity and transportation fuels and its price has been hitting record height every other day. Thus, the only possible solution to this crisis is to find a sustainable (renewable) and economically feasible source of alternative energy. There are many alternative energies that may fulfill the first criterion (sustainable) such as wind, solar, geothermal and biomass. However, not many of them can fulfill the second criterion (economically feasible). The best option that would fulfill both criteria is biofuels, particularly from readily available biomass feedstock such as sugarcane, corn, seed oil from soybean, rapeseed and palm. It has been proven scientifically that sugarcane and corn can be converted to bioethanol while the various oilseeds to biodiesel, efficiently. Since all these feedstock are readily available, they are indeed a quick solution to this crisis. Apart from that, utilization of biofuels contributes to net zero carbon emission which subsequently would mitigate the effect of global warming and overcoming the dwindling reserves of fossil fuel. However, the idea of converting food to fuel while millions of people in the world are suffering from malnutrition prompted stern criticisms from non-governmental organizations (NGOs). Besides, the escalating production of biofuels from food sources is blamed for the rising prices of oils and fats in the world market. Thus, there is an urgent need to address this food versus fuel feud, before it is blown out of proportion.

Palm oil is one of the world's most traded commodities that has fallen trap into this food versus fuel debate. It is the largest edible oil by dominating 25% of total global oils and fats production in 2007 and has been perceived as the most promising feedstock for biodiesel production [1]. Recently, the gradual increment of palm oil's price in the world market has resulted in shortage of supply in palm oil-related products in Malaysia. Consequently, the rising production of biodiesel from palm oil is blamed for this scenario. However, according to the latest statement from Malaysian Palm Oil Council (MPOC) the accusation was shown to be baseless. It was reported that extensive replacement of soybean with corn in the United States (US) and government's policy in Europe to promote rapeseed oil as biofuels feedstock were the main reasons behind the shortage in soybean and rapeseed oil global market. Consequently, food manufacturers had to utilize palm oil as the alternative source of oils and fats which prompted substantial increase in palm oil price. Apart from that, oil palm cultivation has always received negative criticisms regarding its nutritional facts and environmental impacts. On the other hand, there is also strong opposition to palm oil-derived biodiesel entering European Union (EU) and the US market as the sustainability of palm oil feedstock is severely questioned. Fortunately, with more than 160 nutritional research projects and sustainable measurements carried out by Malaysian Palm Oil Board (MPOB) and Malaysian palm oil industry, respectively, palm oil has been proven as a sustainable crop which consists acceptable ingredient for food applications with ample health benefits [2].

Currently, Malaysia and Indonesia accounted for more than 90% of global palm oil production. Hence, it is well justified to explore Malaysian palm oil industry as a case study on how food resource can be managed sustainably in order to overcome the food versus fuel feud. In the initial part of this study, the benefits of palm oil as a source of edible oil and biodiesel were given, highlighting on the economical and sustainability benefits. In the subsequent section, the ability of palm oil in fulfilling the current and future demand as a source of edible oil was thoroughly discussed. Finally, various strategies and possibilities were presented on how palm oil can be a solution for the food versus fuel feud and subsequently towards a sustainable future.

2. Palm oil as a source of food (edible oil)

Palm oil has diversified from a vegetable oil that was heavily criticized for its un-healthy nature to a food source that feed some 3 billion people in 150 countries with proven scientific findings on its health benefits [3]. Besides, palm oil has surpassed soybean oil as the world's leading edible oil, and thus its role as a source of food has become very prominent. In this section, a brief discussion will be given on why palm oil must retain its role as one of the major edible oil worldwide. The discussion will cover various aspects including the current statistic of palm oil production and the advantages of palm oil as a source of edible oil including sustainable supply, cost effectiveness and simultaneous production of protein via livestock crop integration (LCI).

2.1. Current status of palm oil as a source of oils and fats

As an overview of the world's statistic, a total of 154 million tonnes of oils and fats were produced in 2007 compared to 149.6 and 140.7 million tonnes in 2006 and 2005, respectively [1,4]. These figures refer to the production of 17 major oils and fats, comprising from vegetable oils (i.e. soybean, cottonseed, groundnut, sunflower, rapeseed, sesame, corn, olive, palm, palm kernel, coconut, linseed, and castor) and animal fats/oils (i.e. butter, lard, tallow, grease and fish oil). In terms of production, palm oil is the leading vegetable oil with the highest production of 38.5 million tonnes as shown in Table 1. Hence, palm oil has proven that it has the capacity to be the largest source of edible oil which was previously dominated by soybean oil.

Malaysia alone accounted for more than 40% of the total world palm oil production. In fact, for the past five decades, Malaysia's oil palm plantation area and crude palm oil production have been increasing gradually. From a mere 54,000 ha in the early 1960s, it increased steadily to reach 4.3 million hectares in 2008 [5]. Simultaneously, Malaysia's crude palm oil production increased from 2.6 million tonnes in 1960 to 15.8 million tonnes in 2007 as shown in Table 2. In addition, the production of crude palm oil is expected to further increase to 16.3 million tonnes in 2008 due to more trees expected to mature and bearing more fruits [6].

2.2. Cheapest supply of edible oil

In terms of production cost, palm oil stands out as the least expensive oil to be produced per tonne compared with other major vegetable oils as shown in Table 3 [7]. For instance, the production cost of palm oil is US$ 228 per tonne while for rapeseed oil in Canada and Europe, the price is more than double compare to palm oil. This may be rationalized as oil palm is a perennial (it grows every year without annual sowing) and may be considered a low energy input crop. On the other hand, rapeseed is a high energy

Table 1
World's oils and fats production in 2007.

Oil	Volume (million tonnes)	%Share
Palm	38.5	25
Soybean	36.96	24
Rapeseed	18.48	12
Sunflower	10.78	7
Animal fats	24.64	16
Other	24.64	16
Total	154	100

Table 2
Malaysia crude palm oil production and exports from 1980 to 2008.

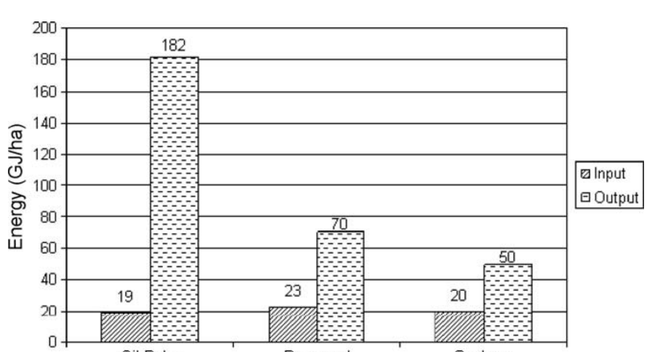
Year	Production (million tonnes)	Export
1980	2.6	2.3
1990	6.1	5.7
2000	10.8	9.1
2005	15.0	13.5
2006	15.9	14.4
2007	15.8	13.7
2008 (forecast)	16.3	–

Table 3
Comparative cost for the production of selected oils (USD/ton).

Oil	Cost (USD/ton)	Country/region
Palm	228	Malaysia
Soybean	400	USA
Rapeseed	648	Canada
Rapeseed	900	Europe

input crop; the land must be ploughed, the seed must be sown and the land is fertilized every year. This may be further supported by the ratio of output to input energy for the various crops. The ratio of output to input energy generally give an indication on how much energy is required (input energy) to produce certain amount of energy (in this case, the energy content in the oil). The energy input includes fertilizer, milling, etc. The input and output energies for oil palm, soyabean and rapeseed are shown in Fig. 1 [8]. The output to input energy ratio for oil palm is 9.6, way higher as compared to rapeseed (3.0) and soybean (2.5) indicating that less fertilizer, diesel for machinery and agro-chemical usage is required to produce 1 ton of palm oil as compared to soyabean and rapeseed oil.

Moreover, Malaysia's palm oil industry do not receive any subsidy from the government, but pays a substantial direct income to the state government through numerous taxes, fees and levy payment [9]. On the contrary, European and American counterparts are not only exempted from taxes, but enjoy luxurious subsidy from their governments for every hectare of vegetable oil produced. For instance, in 2006 the net income received from agriculture crop in the UK is equal to USD 1797/ha/year, of which USD 387/ha/year was the subsidy component. Compared to this, the Malaysian palm oil industry which is not subsidized, earn USD 2503/ha/year which exceed the UK agriculture unit earnings [9]. Therefore, the sustainability of Malaysian palm oil industry is very



Output/Input	Oil Palm	Rapeseed	Soybean
GJ/ha	9.6	3.0	2.5

Fig. 1. Comparison of energy input to produce palm, rapeseed and soybean oil.

obvious and comparable to any large scale agriculture in the tropics or the temperate countries.

2.3. Ample health benefits of palm oil

Oils and fats are an essential component of a balanced human diet and the World Health Organization (WHO) recommends that 30% of the energy requirements of an individual should be obtained from oils and fats [4]. Therefore, lowest cost alone is not sufficient to make palm oil an important source of edible oil in the world, unless it contains the necessary nutrition required for human's daily diet. At one time, palm oil was labeled as an unhealthy oil due to its high content in saturated acid namely palmitic (44%) and stearic (5%), which was found to increase the risk of cardiovascular diseases substantially [10]. However, after years of research the findings were found to be otherwise. Unlike other edible oils, palm oil is a balanced oil that contains equal amount of both unsaturated (mainly oleic) and saturated (mainly palmitic) fatty acid, with the former constituted mostly by the preferred mono-unsaturates. Palmitic and stearic in palm oil also does not appear to elevate cholesterol levels in the normal ranges [11,12]. Thus, palm oil is included as one of the 17 edible oils which has been accepted and certified in meeting the FAO/WHO food standard requirement under the CODEX Alimentarius Commission Programme [13].

In addition, the minor constituents in palm oil, namely: carotenes (pro-vitamin A), tocopherols and tocotrienols (pro-vitamin E) have other beneficial health properties including as antioxidant, anti-cancer and cholesterol lowering effect [14–17]. Besides, palm oil exhibits natural semi-solid state at room temperature and therefore for most food uses, palm oil does not required hydrogenation, thus avoiding the formation of trans-fatty acid (TFA) [18,19]. The main problem with hydrogenated oils is during the hydrogenation process, polyunsaturated fats are transformed into TFA, a toxic artificial fat. It was reported that TFA promotes heart disease, diabetes, auto-immune disease and a host of other health problems [20]. Over the years, palm oil has indeed become an integral part of the human diet all over the world. In the part of the world in which palm oil has been used as a staple oil such as Malaysia, Indonesia, Papua New Guinea and Nigeria, common illnesses such as heart disease, diabetes and cancer have been reported to be relatively low, attesting to its healthful nature [21]. For instance, in Malaysia, average diet for an individual consists of about 27% fat, of which 80% comes from palm oil [21].

2.4. Versatility of palm oil for Islamic countries

The growing demand of oils and fats in the Islamic countries has now created a niche market for oils and fats. Many of the Islamic countries always experience chronic shortages in the supply of oils and fats, thus causing food insecurity in those countries. Many Islamic countries like Bangladesh, Egypt, Nigeria, North African countries (Algeria, Morocco, Tunisia), Iran, Pakistan, Saudi Arabia and Turkey are net importers of oils and fats [22]. In year 2006, it is heartening to note that Malaysian palm oil accounted for 53% of total oils and fats imported by Islamic countries [22,23]. Palm oil has become an attractive choice for Islamic countries due to price competitiveness, year round supply and suitable for edible and non-edible application. This eventually does not only helps them to save on costly cultivation of oilseeds, but allows them to reserve land for the cultivation of food crops, thus ensuring food security in the country.

In non-Islamic countries, bread and other food items are often made using lard or non-*halal* animal fats. These products are

Table 4
Various crop–oil palm combination for agro-forestry system that are considered viable and still under development.

Main crop	Viable projects	Under development
Oil palm	Oil palm + cash crops	Oil palm + timber trees
	Oil palm + cattle	Oil palm + rattan
	Oil palm + sheep	Oil palm + medicinal plants

imported by Islamic countries; however, the *halal* status of the fats used is not easily ascertained. However, palm oil would have easily overcome this problem as it has been certified as meeting the "*halal*" requirement by Islamic Development Department of Malaysia (JAKIM) when used in food and non-food industries [24]. Malaysian "*halal*" certification provided by the JAKIM represents the highest standards and is recognized by international bodies such as the Codex Alimentarius Commission of the United Nations. Therefore, consumers from Islamic countries will have greater confidence in buying and using products that uses Malaysian palm oil as a source of oil or fat. This will also boost the marketability of food products produced from non-Islamic countries.

2.5. Agro-forestry and livestock crop integration (LCI)

The nature of oil palm tree which grows to a height of 20–30 ft. allows the implementation of agro-forestry in oil palm plantation. Agro-forestry is an integrated approach that allows the sharing of land for production of both agriculture and forestry products, thus optimizing utilization and maximizing returns on the same piece of land. For instance, apart from oil palm cultivation, animal rearing can be carried out simultaneously as a source of meat. However, the success of this integrated concept depends heavily on the selection of suitable and proper short-term crops and livestock. Some of the possible combinations are listed in Table 4 [25,26].

For instance, the integration of short-term cash crops such as sugarcane, banana and pineapple in immature oil palm plantations carried out by MPOB has been producing additional income to the owners while the oil palm trees are still immature. This eventually yield an additional profit of RM 533/month from 2 ratoons of yellow sugarcane per hectare of oil palm, RM 832/month from two harvests of banana per hectare of oil palm and RM 231/month from one round harvest of pineapple per hectare of oil palm, respectively [27]. Besides, these crops are normally planted in between the rows of oil palm trees that are normally filled with unwanted weeds, shrubs and grasses [28].

Nevertheless, planting other crops along side oil palm may only be applicable when the plant is not fully grown. A better option that is more feasible in a long run is to rear livestock such as cattle. This is called livestock crop integration system where sources of protein and carbohydrate can be produced under the same oil palm plantation. This would be an ideal combination for Malaysia since Malaysia currently imports 80% of the beef for local consumption [29]. Research shows that 1 ha of grazing area in a plantation can accommodate one head of cattle. Thus, a moderately sized plantation with sufficient grazing ground could accommodate up to 500–1000 of cattle [30]. Oil palm plantations have been shown to be able to fulfill all these requirements and this system has benefited farmers especially in saving labor cost up to 50% per hectare per year, reducing weeding cost by 30–50%, increase oil palm fresh bunch by 6–30%, lower usage of chemical fertilizers and improvement of soil structure through the addition of organic matter to the soil [31]. Hence, LCI system again justifies the sustainability of oil palm plantation and promotes food security initiatives in order to strengthen the focus on a diversified food basket as oil palm plantation not only produces edible oil but also livestock.

Table 5
Oil yield and world plantation area for major edible oils.

oil crop	Average oil yield (ton/ha/year)	Planted area (million hectare)	% of total planted area
Soybean	0.40	94.15	42.52
Sunflower	0.46	23.91	10.80
Rapeseed	0.68	27.22	12.29
Oil Palm (mesocarp)	3.62	10.55	4.76
Total*		221.45	

Note: *Only for the seven major oilseeds.

2.6. Sustainability of palm oil

In terms of sustainable productivity of the world's oils and fats, oil palm would require a smaller area to achieve a fixed amount of oil compared to other vegetable oils. According to Oil World 2007, oil palm is grown on less than 5% of the world's agriculture land for major edible oils production but it accounted for 25% of the global market share as shown in Table 5 [32]. For a similar output, soybean cultivation took up about 10 times more land, testifying that palm oil is 10 times more efficient than soybean in terms of land usage. Thus, if the objective is to optimize land usage for cultivation and subsequently to fulfill the booming world's population, palm oil will stand out as the best candidate since it can produce the largest quantity with minimum land requirement, thus ensuring sustainability in the future.

In 2007, Malaysia only utilized 4.3 million hectares of its land for oil palm plantation or 1.85% of the world oilseed area. This is a very small figure considering the fact that palm oil industry in Malaysia has span over 90 years of development since the industry was first established in 1917 [32]. Furthermore, more than 25% of this land area is attained from converting land previously planted with rubber, coconut and cocoa. On top of that, over 50% of the country's land still remains as tropical forests, indicating that claims of deforestation for palm oil plantations in Malaysia to be baseless [33]. For instance, Malaysia's total agriculture land is less than 19% with palm oil accounts for two-third of it. On the contrary, Britain has less than 12% of its land under forest cover of which 71% of its total land area is utilized for agriculture purposes [34]. With such a small land usage in Malaysia, it is rather surprising to see that Malaysia is currently controlling the palm oil commodity by being the world largest trader (27.9%) for the global oils and fats in the years 2006 as shown in Fig. 2 [7].

Malaysia has a well-managed land usage policy which is comparable to sustainability standard practiced in EU or elsewhere. Palm oil in Malaysia, similar to oilseeds in the EU, is produced on legitimate agricultural land and does not involve replacement of primary forests or the destruction of wildlife habitats, particularly in Peninsular Malaysia which is not the habitat for orang utans [35]. Furthermore, with the establishment of the Round Table on Sustainable Palm Oil (RSPO) in the way, palm oil producers in Malaysia are working closely with international organizations such as World Wildlife Fund (WWF) to ensure the sustainability of oil palm plantations. Through RSPO, a trading system and certification protocol for the sustainability of palm oil produced have been developed and trial audits are currently underway. This action is a testament of transparency in Malaysia's palm oil industry and has been proven as a sustainable way to provide sufficient edible oils for the world's growing population while conserving land area required for other plantations.

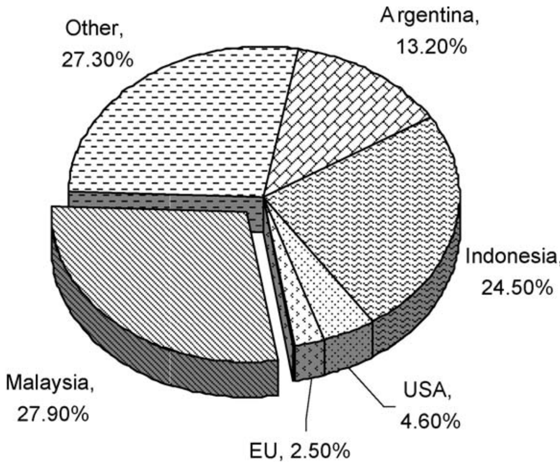


Fig. 2. Global Oils and Fats Trade in 2006.

3. Palm oil as a source of biofuel

For the past two decades, the search for alternative energy which is renewable and environmental friendly has been carried out extensively over the world. This is mainly due to the high demand and limited supply of fossil fuels in the world market causing its price to soar to unprecedented height lately especially crude petroleum. Currently, there are many types of renewable energy that are being heavily researched and developed in the world, namely solar, wind, hydrothermal, geothermal and biofuels. However, apart from biofuels, all these renewable energy are only able to generate electricity and thermal energy from infinite sources while 40% of total energy consumption in the world is in the form of liquid fuels such as diesel or gasoline. Hence, the most attractive and practical choice to replace fossil fuels as the main source of energy would be biofuels, which are mostly in liquid forms. Generally, biofuels can be divided into a few categories such as biodiesel, bioethanol, biomethanol and biohydrogen. Among all, biodiesel has been receiving a lot of attention due to similarity between biodiesel and conventional diesel in terms of chemical structure and energy content. Besides, no modification in diesel engine is required as biodiesel is compatible with existing engine model and has been commercially blended with diesel as transportation fuel in a few countries including Germany, Italy and Malaysia. In addition, biodiesel is better than diesel as far as sulfur content, flash point, aromatic content and biodegradability are concerned. Biodiesel can be produced from any types of vegetable oils or fats. Since edible oils are readily available feedstock in huge quantities, they can be the immediate feedstock for biodiesel production. Thus, edible oils such as rapeseed, soybean and palm oil are potential feedstock for biodiesel production. In this section, the quality and the advantages of producing biodiesel from palm oil as compared to other major world edible oil will be presented.

3.1. Quality of palm oil-derived biodiesel

Biodiesel produced from palm oil (palm diesel) has been found to have very similar fuel properties to petroleum-derived diesel [36]. From 1983 to 1994, palm diesel was successfully evaluated as diesel substituted with extensively field trial. It was reported that neat palm biodiesel (without mixing with petroleum-derived diesel) can be used as fuel in diesel engine without any modification [37]. It can also be blended in any proportions with petroleum diesel when tested on diesel engines, including Mercedes Benz engines over 300,000 km [36]. No technical problem was reported throughout the field trial, provided the engines were maintained according to their service manual [36]. Eventually, the palm diesel was found to meet the international standard, such as European Standard for Biodiesel (EN14214) and ASTM D6751.

3.2. Energy efficiency and cost competitiveness of palm diesel

According to the latest analysis from Rabobank, the total cost for producing palm diesel in Malaysia and transported to a petrol kiosk in EU is about US$ 784–804 per tonne. The detail calculation is shown in Table 6 [38]. This price is also compared to biodiesel produced from locally obtained rapeseed in EU and soybean from the US. Comparatively, the price of biodiesel obtained from soybean and rapeseed is higher at US$ 831–851 per tonne and US$ 1029–1046 per tonne, respectively. These figures are based on the average prices of each vegetable oil, including approximately 20% cost of production, international freight and domestic distribution

Table 6
Comparison of estimated cost for producing biodiesel from palm, rapeseed and soybean oil.

Component cost (US$/ton)	Palm oil from Malaysia	Rapeseed oil from EU	Soybean oil from US
Feedstock (freight on board (FOB) at production country)	547	800	604
Biodiesel production cost:			
Solvents, acids and chemicals	47	–	–
Other costs	35	–	–
Adjustment for energy parity with petroleum diesel (based on 90% of kJ/kg of energy of petrol-diesel)	55	–	–
Total	137	196	150
Cost of biodiesel	684	996	751
Estimated freight and insurance cost to Rotterdam	70	–	50
Total cost in EU	754	996	801
Local distribution (approximation)	30–50	30–50	30–50
Total cost at petrol kiosk in EU	784–804	1,029–1,046	831–851
Price of retail biodiesel (Germany)[a]		1,322	

Assuming production plant with capacity >100,000 ton/annum; other figures based on pricing as at Match 2007.
[a] F O Licht based on UFOP Marktinformation (3-month average retail prices from November 2006 to January 2007).

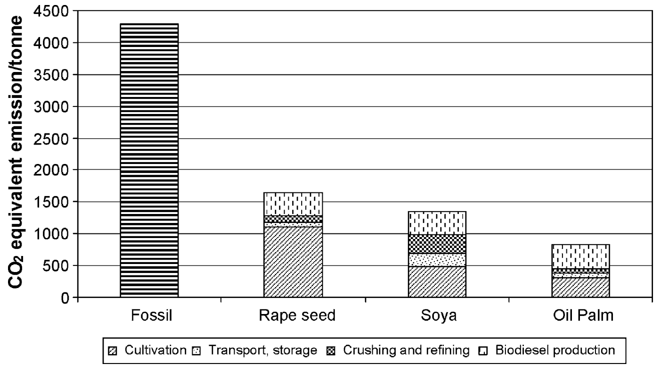


Fig. 3. Comparative amount of CO_2 emission from diesel derived from various sources.

charges. The reported biodiesel retail price in Germany based on 3-month averages from November 2006 to January 2007 is also given in Table 6 which is at US$ 1332 per tonne. Hence, Malaysian palm diesel has been shown to be the lowest in terms of production cost in the global market for biodiesel.

3.3. Palm diesel towards green house gas (GHG) mitigation

Biofuels are politically desirable worldwide in view of serious concerns over the rising levels of greenhouse gas, mainly carbon dioxide (CO_2) which is responsible for global warming. The use of biodiesel can mitigate the emission of CO_2 because all biodiesel are derived from living plants that requires CO_2 for its growth. With the addition of water and energy from the sunlight, plant organisms will synthesized the absorbed CO_2 to carbon-based sugar molecules which is required for plant growth through photosynthesis. Therefore, although CO_2 is emitted when biofuel is used as a source of energy, the net CO_2 emission is still considered zero. On the other hand, fuel that release less CO_2 is considers more environmental friendly as compared to otherwise. Fig. 3 shows the amount of CO_2 emitted from per tonne of diesel derived from various sources; petroleum, palm, rapeseed and soybean, through the life cycle assessment (LCA) study [39]. The main advantage of using palm diesel is that the emission of CO_2 is the lowest compared with fossil diesel and biodiesel derived from other crops due to less fertilizers, pesticides and machinery usage during oil palm cultivation. Moreover, it was also reported that palm trees have very high photosynthetic rates, capable of absorbing up to 10 times more CO_2 and emits 8–10 times more oxygen per hectare per year compared to annual crops grown in temperate countries [9].

4. Concerns of food security for palm oil

According to Berck and Bigman [40], food security refers to the availability of sufficient food to sustain life and to ensure good health of all the world population at all the times, across all countries, regions, incomes group and all members of individual households. Although there are large surpluses of food in some countries, hundreds of million people in other countries still face the food shortage scenario. Thus, extensive conversion of crops such as corn, soybean, and palm oil to biofuels may create serious food shortage and resulted in growing number of malnourish people. Apart from that, this may also lead to substantial price increase in food and subsequently inflation rate in countries that are heavily dependent of imported food. At present, evidence that biofuels lead to food price increases is only circumstantial. According to World Bank (2006), analysis of variation in world grain prices suggests that they have decline in real terms [41]. In fact, among the three main staples – rice, wheat and maize, only maize is currently utilized to produce bioethanol. However, the use of edibles oil such as soybean, rapeseed and palm may face more serious circumstances. In this aspect, a thorough study on palm oil will be discussed.

Table 7
Ending stock of palm oil in Malaysia in December 2006 and 2007.

Closing stock	2006 (ton)	2007 (ton)	Difference (%)
Palm oil	1,506,035	1,682,587	11.7
Palm kernel	16,117	170,539	5.8
Palm kernel oil	362,723	268,842	−25.9

As far as food security for palm oil as a source of edible oil is concerned, there are two main factors that are crucially important. The first factor is that it should have ample supply to meet the current market demand and also for future expanding demand. Second, its price should be at a state that it is stable and affordable for majority of the world's population. Hence, the current supply of palm oil in meeting the world demand for oils and fats will be discussed. As an indication on whether palm oil is sufficient to meet the existing demand, the ending stock of palm oil will be taken into consideration. Table 7 shows the year-ending stocks of palm oil in 2006 and 2007 [5]. It is surprising to note that although the export of biodiesel produced from palm oil in Malaysia increased from 47,986 ton in 2006 to 89,132 ton in 2007 (an increment of 85.7%), there was no reduction in the year-end stock. Instead, from Table 7, the excess supply of palm oil increased from 1.5 million tonnes in 2006 to almost 1.7 million tonnes in 2007. This shows that the conversion of palm oil to biodiesel does not cause any shortage in meeting the world demand for edible oils and fats. Instead, there is still ample amount of palm oil that can be converted to palm diesel to meet the increasing demand of the fuel. This figure has yet to take into account the excess amount of palm kernel oil that can also be converted to biodiesel.

Looking from the pricing perspective, it is undeniable that based on Fig. 4, the price of edible oils has increase significantly in the last 2 years. For instance, the price of palm oil has increased almost 2 folds from a mere USD 400/metric tonne in 2006 to USD 800/metric tonne in 2007. However, based on the increasing year-end stock of palm oil, it can be concluded that the conversion of palm oil to biodiesel is not the main reason for the price hike of palm oil in the global market. Instead, many other reasons have been cited such as the increasing demand from the fast growing population in China and India and natural disasters such as snowstorms and droughts in China and India, respectively, which tightened the supply of soybean and rapeseed oil in the world

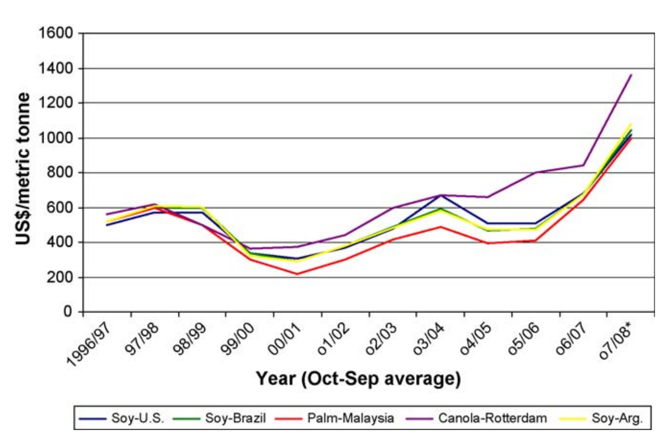


Fig. 4. Comparison of Malaysian palm oil with other major oilseed prices.

market [42,43]. All these events have caused the price of soybean and rapeseed to increase significantly. In line with the increase in the prices of soybean and rapeseed, the price of palm oil would have expected to increase, as three of these oils control more than 60% of the world edible oils and fats market. In another words, the price of palm oil would have increased, irrespective if palm oil is or not used as a feedstock for biodiesel production. Furthermore, based on the figures presented in 2005, only 1% of the total world production of palm oil is being used for biodiesel. This amount is way much lower to have a significant impact on the price of palm oil and also compared to the 13% of corn being used for bioethanol production in USA. Therefore, it is clear that the recent price increase in palm oil was not due to the conversion of palm oil to biodiesel.

5. Addressing the food versus fuel feud for palm oil

Nevertheless, palm oil being one of the three major sources of edibles oils and fats in the world is not exempted by the changes encountered by soybean and rapeseed oil which are currently experiencing shortage due to limited supply. For instance, a shortage in soybean oil resulted in overwhelming demand of other substitutes such as palm oil. Subsequently, it inflicted an acute shortage of palm oil and eventually increased the price of palm oil unnecessarily. In actual fact, palm oil itself is not experiencing shortage, but the price hike is caused by the shortage of soybean oil. In 2006, only 10 countries in the world are self-sufficient in the supply of oils and fats, including Malaysia, owing to its oil palm industry that is currently exporting palm oil to over 150 countries worldwide [4]. Major net importers like China, India and EU depends on oils and fats imported to fulfill their local consumption. The world demand for oils and fats is expected to experience a minimal growth rate of 3% annually [44]. On the other hand, based on a conservative forecast, Malaysian palm oil is also expected to expand by at least 3% next year and up to 10% in the years to come as more trees is expected to mature in the very near future [6]. Assuming that the increase in the demand of oils and fats is in accordance with the individual type of fats and oils, therefore, palm oil is set to be able to fulfill the increasing world demand for oils and fats. It is worth to note that this has yet to take into account the year-end stock for palm oil. Therefore, it is evident that palm oil is indeed a sustainable source of edible oil that can meet the future increase in demand of edible oil.

However, as presented in the earlier section, palm oil is not only a nutritious, sustainable and economical source of edible oil, but it is also a sustainable feedstock for biodiesel production. Currently, the global biodiesel market is led by Europe. In a bid to further boost the use of biofuels in the European transportation sector, EU leaders have committed to raise the share of biofuels in transport to 5.75% in the year 2010. Therefore, the demand for biodiesel in Europe alone is expected to increase to more than 10 million tonnes/year in the year 2010. Currently, EU rapeseed production amounts to only 6 millions tonnes. Thus, even if all the rapeseed available is used for biodiesel production and none goes into food industry, it will only be able to supply 60% of the target demand [45]. Eventually, Malaysian palm diesel will be best positioned to fill the supply gap.

In the recent years, Malaysia herself has also put a lot of emphasis for the possible utilization of biodiesel. At the current rate of production, the average lives for Malaysia's oil and gas reserves are 16 years and 32 years, respectively. If no new discoveries of oil wells are made, Malaysia will be a net importer of petroleum by the 2100s and thus alternative renewable fuels have to be sought. Diesel consumption in Malaysia in 2002 was 8.61 million tonnes with 50% of that consumed by the transportation sector [46]. Therefore, palm diesel also has a very prominent role in Malaysia. In 2006, the Malaysian biofuel policy was released with the objective to ensure healthy development of biofuel industry, inline with the Five Fuels Diversification Policy. The policy is underpinned by five strategic thrusts: (i) Thrust 1: biofuel for transport, (ii) Thrust 2: biofuel for industry, (iii) Thrust 3: biofuel technologies, (iv) Thrust 4: biofuel for export and (v) Thrust 5: biofuel for cleaner environment. In order to implement the policies successfully, staggered strategies have been planned out. Short-term measures include the establishment of Malaysian standard specifications for B5 diesel (5% palm olein, 95% petroleum diesel) and by providing B5 diesel to selected government departments and to the public via diesel pumps at selected petrol station for trial run. Medium term measures include wide application of palm diesel throughout the country and export markets will be established. Effort will also be made to get engine manufacturers to extend their warranties to cover the use of B5 diesel and to enact legislation to mandate the use of B5 diesel in transport sector. For long-term measures, the proportion of palm diesel in the diesel blend will be gradually increased. By the end of year 2007, there were five biodiesel plants operated in Malaysia with the total capacity 399,000 ton/year [47]. In view of the global market potential on palm diesel, there will be synergistic opportunity for Malaysia, being the second largest producer of palm oil in the world.

Nevertheless, at the current state, Malaysian palm oil is still not ready to be converted to palm diesel in a large scale. In 2007, the excess supply of CPO in Malaysia was 1.68 million tonnes. According to Meher et al. [44], if palm oil is transesterified continuously at 70 °C in methanol with sodium methoxide as catalyst, methanol to oil molar ratio of 17:1, the conversion of palm oil to biodiesel is approximately 99%. Thus, with 1.68 million tonnes of CPO as feedstock, 1.66 million tonnes of palm diesel can be expected to be obtained. This amount would have met more than 50% of the biodiesel consumption in EU for the year 2005 which stands at about 3 million tonnes. Nevertheless, this value is still very far from the required 10 million tonnes required by the year 2010.

Based on the data presented up to this stage, it is clearly established that palm oil is indeed the largest edible oil with lots of health benefits and at the same time, a sustainable feedstock for biodiesel production. Removing either one of the usage of palm oil, either as a source of food or fuel, can no longer be an option as both are necessity in human civilization rather than luxury. Alternatively, clearing more land without proper planning to increase its production is also not a viable solution in terms of environmental consideration. Therefore, the only way out is to further increase the yield of palm oil.

Recently, the Malaysian oil palm industry has entered into a new dimension by the successful cloning of oil palm tree. The oil palm clones produced by Applied Agriecological Research Sdn. Bhd. (AAR) are reported to be able to produce up to 10.6 ton/ha/year crude palm oil. This value is at least 20–25% higher than the yield of conventional seedling. Besides, this new breed of oil palm clones have shorter maturity period of two years as compared to two and a half for the old breed. Apart from that, the new clone is also shorter, making the harvesting process easier. Currently, there are more than 10 oil palm tissue culture laboratories in Malaysia with a total production rate of 2 million seedlings of oil palm per year. However, the price of clone oil palm seedling is RM20 each, much more higher than the conventional price of hybrid oil palm seed which is RM1.35 each. Therefore, Malaysia Palm Oil Board (MPOB) is taking initiative step to sponsor the producers of clones and planters of oil palm to replant their old oil palm tress with high-yielding ones [48,49]. Give and take 3 years for this replacement to be completed in 1 million hectares of land planted with 2 million cloned palms. Based on the basis oil yield of 5 ton/ha/year, cloned palm trees have average 20% higher yield resulted in 1 ton higher oil yield per hectare. Consequently, it would be able to provide an additional 1 million

tonnes of palm oil annually. If all the addition palm oil is converted to biodiesel according to Meher et al. [44] reaction condition, 990,000 ton of biodiesel will be produced. This would be sufficient to meet 10% of the biodiesel demand in EU by year 2010. Considering in the Indonesia also does the same, an additional 1 million tonnes of palm oil will be available.

Apart from that, perhaps it is also timely for the oil palm industry in Malaysia to set up its own "Plantation University", dedicated not only to training human capital to better manage the industry, but also undertaking further research and development in the basic sciences to support the applied R&D currently pursued by Malaysian Palm Oil Board and some palm oil companies [42]. Though the case for such a university is strong, not everyone in the industry supports the idea. But there is an urgent need to evaluate the pros and cons of the idea. Existing data information of oil palm can be assembled and verified through the "Plantation University" so that a well-designed information technology package can be developed and easily accessible. In addition, more research and development on advance planting strategies, more specialized fertilizer, biotechnology, biodiesel production from palm oil technologies, etc. can be done in "Plantation University" to enhance the production and productivity of palm oil in an economical and environmental way. Thus, palm oil can then play an equal role as a source of food and fuel for a sustainable future.

6. Conclusion

Based on the overview presented, it is clearly established that palm oil is indeed the largest edible oil with proven health benefits and at the same time, a sustainable feedstock for biodiesel production. With proper management and strategies, production of biodiesel from palm oil was also shown not to threaten the oils and fats global supply in the next 10 years. Instead, palm oil can actually become an important feedstock to feed the world global demand for oils and fats (food) and contribute to global energy security while providing environmental sustainability.

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